TITLE OF THE INVENTION

[0001] Laminated Wood Piece and Door Containing the Same

BACKGROUND OF THE INVENTION

[0002] Wood is a common material used to construct doors and other architectural building elements. However, in recent years the cost of solid timber wood has increased dramatically as its supply shrinks due to the gradual depletion of old-growth and virgin forests. It is particularly expensive to manufacture doors from such material because typically less than half of harvested timber wood is converted to natural solid wood lumber, the remainder being discarded as scrap.

[0003] Accordingly, because of both the cost of high-grade timber wood as well as a heightened emphasis on conserving natural resources, wood-based alternatives to natural solid wood lumber have been developed that make more efficient use of harvested wood and reduce the amount of wood discarded as scrap. Plywood, particle board and oriented strand board ("OSB") are examples of wood-based composite alternatives to natural solid wood lumber that have replaced natural solid wood lumber in many structural applications in the last seventy-five years. These wood-based composites not only use the available supply of timber wood more efficiently, but they can also be formed from lower-grade wood species, and even from wood wastes.

[0004] Wood composite materials are especially suitable for manufacturing doors, because their strength and insulation are comparable or superior to natural solid wood lumber. However, because these composite materials consist of small particles (particle board), wood strands (OSB), flat pieces of low-grade wood species or some similar such material, products made from them do not have an attractive, grained appearance, but rather tend to have unsatisfactory aesthetic finishes. This may make them unsuitable for use in doors, because generally it is preferred that doors have a pleasing aesthetic finish. However, wood composite materials can be used to form the internal "core" of the door, and then top and bottom "doorskins" having a wood or wood grain appearance are applied to the planar surfaces of the door to give it a satisfactory aesthetic finish.

[0005] Typically before these doorskins are applied to the internal core, the core is "framed" with wood strips. The wood strips may are placed adjacent to the top and bottom horizontal edge surfaces of the door (in which case they are known as "rails") or they may be placed adjacent to the vertical edges of the door (and are then known as "stiles"). In addition to providing a pleasing aesthetic finish to the sides and edges to match the appearance of the aforementioned doorskins, the rails and stiles also enhance the structural integrity of the door and help resist warpage. The stiles are also particularly important because metal fixtures (such as the hinges that hold the door to the door frame, as well as the door lock) are installed in the door stile and held therein.

[0006] Preferably, each door stile would be manufactured from a single piece of solid hardwood, which would provide not only an attractive finish, but provide excellent strength for holding the lock and hinge fixtures. However, one-piece solid hardwood stiles are prohibitively expensive for use in most all doors. Accordingly, laminated wood materials have been proposed as an alternative to one-piece solid hardwood stiles. These laminated wood composite styles are made by laminating an outer hardwood strip to a "stile backer" made from a wood composite material. The outer hardwood strip provides a natural wood appearance, while the wood composite material provides screw holding strength, so that metal fixtures may be attached to the stile.

[0007] However, while these laminated composite stiles are considerably less expensive than one-piece hardwood stiles they have poor screw-holding strength and poor split resistance. The "screw-holding" strength is the amount of force required to pull a screw out of the stile, while the split resistance measures how well the wood resists splitting when a nail or screw is inserted into it. These properties are important because they indicate whether the metal fixtures will be able to withstand the forces, static and dynamic, exerted on and by a hung door.

[0008] For example, one commonly available laminated wood material is the TIMBERSTRAND™ product from Trus Joist MacMillan, Inc., Boise, Id. In the TIMBERSTRAND™ wood composite material, the layers are arranged perpendicular to the lower and upper surfaces of the solid hardwood component attached to wood composite material. Thus, the layers of the wood composite material are oriented perpendicular to the surface of the door stile (and thus parallel to the direction that the screw enters the wood composite material). Accordingly when a screw is inserted into the wood composite layers it

has the effect of pushing the layers apart from each other, which not only reduces the screw holding strength of the laminated wood door stile, but also reduces the split resistance.

[0009] Given the foregoing, there is a continuing need for a laminated wood stile that not only has a pleasing surface finish and is inexpensive, but that also combines excellent screw holding strength and split resistance to allow for the installation of metal fixtures within it.

BRIEF SUMMARY OF THE INVENTION

[0010] The invention provides a laminated wood piece comprising a solid hardwood component having an upper surface and a lower surface that are substantially parallel to each other and a wood composite component having layers oriented substantially parallel to the lower surface of the solid hardwood component, the ratio of a thickness of the solid hardwood component to a thickness of the wood composite component being from about 1:1 to about 1:10.

[0011] The invention also provides a door including a frame, the frame including at least one stile member, the at least one stile member comprising a solid hardwood component having an upper surface and a lower surface that are substantially parallel to each other; and a wood composite component having layers oriented substantially parallel to the lower surface of the solid hardwood component. The ratio of a thickness of the solid hardwood component to a thickness of the wood composite component is from 1:1 to 1:10, preferably from 1:1 to 1:5.

[0012] The invention also provides a method for manufacturing a door comprising the steps of providing a core, then providing a door stile comprising a solid hardwood component having an upper surface and a lower surface that are substantially parallel to each other, and a wood composite component having layers oriented substantially parallel to the lower surface of the solid hardwood component. This method further comprises the step of securing the door stile to the core, with the wood composite component contacting the core, and the solid hardwood component being on an outer side of the wood composite component.

[0013] The invention also provides a method for manufacturing a door stile comprising the steps of preparing a wood composite panel having several layers and a thickness of about 0.6 cm to about 6 cm, then cutting the wood composite panel into a plurality of wood composite sections, each wood composite section having a width of about 3 cm to about 6 cm. Next, a solid hardwood component is provided having an upper surface and a lower surface that

are substantially parallel to each other and one of the plurality of wood composite sections is attached to the lower surface of the solid hardwood component, wherein the wood composite section has several layers oriented substantially parallel to the lower surface of the solid hardwood component.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0014] The foregoing summary, as well as the following detailed description of preferred embodiments of the invention, will be better understood when read in conjunction with the appended drawings. For the purpose of illustrating the invention, there is shown in the drawings embodiments which are presently preferred. It should be understood, however, that the invention is not limited to the precise arrangements and instrumentalities shown in the drawings:

[0015] Fig. 1 is a perspective view of a laminated wood piece prepared according to the present invention;

[0016] Fig. 2 is a front view of the laminated wood piece shown in Fig. 1;

[0017] Fig. 3 is a perspective view of a door incorporating a laminated wood piece prepared according to the present invention;

[0018] Fig. 4 is a partial perspective view of a wood composite panel showing the sections the panel is to be cut into according to the present invention; and

[0019] Fig. 5 is a perspective view of a prior art laminated wood piece.

DETAILED DESCRIPTION OF THE INVENTION

[0020] All parts, percentages and ratios used herein are expressed by weight unless otherwise specified. All documents cited herein are incorporated by reference.

[0021] As used herein, "wood" is intended to mean a cellular structure, having cell walls composed of cellulose and hemicellulose fibers bonded together by lignin polymer.

[0022] By "wood composite material" it is meant a composite material that comprises wood and one or more other additives, such as adhesives or waxes. Non-limiting examples of wood composite materials include oriented strand board ("OSB"), structural composite lumber ("SCL"), waferboard, particle board, chipboard, medium-density fiberboard, plywood, and boards that are a composite of strands and ply veneers. As used herein, "flakes", "strands", and "wafers" are considered equivalent to one another and are used interchangeably. A non-

exclusive description of wood composite materials may be found in the Supplement Volume to the Kirk-Rothmer Encyclopedia of Chemical Technology, pp 765-810, 6th Edition.

[0023] The following describes preferred embodiments of the present invention, which provides an elongated laminated wood piece, particularly suitable for use as a stile in a composite door. This laminated wood piece includes a single piece of solid hardwood laminated to layers of a wood composite component (e.g., strands, particles or veneers), these layers arranged substantially parallel to the lengthwise direction of the piece, which, when compared to prior art laminated woods, increases the split resistance and screw-holding strength of the composite piece, provides maximum stiffness along the lengthwise direction of the piece and minimizes the linear expansion in this direction. Laminated wood pieces prepared according to the present invention have a screw holding strength of about 400 lbs to about 1200 lbs and a split resistance of greater than about 600 lbs to about 2500 lbs, such as greater than about 1000 lbs, such as greater than 600 lbs.

[0024] The laminated wood piece may be installed as a stile in a composite door so that the wood composite component faces inwardly towards the center of the door, and the solid hardwood component is on the outer side of the wood composite component to give the edge of the door a pleasing and attractive finish that preferably matches the wood grain of the surface skin veneers.

[0025] As shown in Figure 1, there is an elongated laminated wood composite piece 1 comprising a solid hardwood component 3 and a wood composite component 5. The solid hardwood component 3 has an upper surface 14 and a lower surface 16, which are preferably substantially parallel to one another. The wood composite component 5 is laminated to the lower surface 16 of the solid hardwood component 3. As can be seen in figure 1, the wood composite component 5 is composed of layers 9 arranged substantially parallel to the upper surface of 14 and the lower surface 16 of the wood composite piece 1. When the wood composite component 5 is made from OSB, then at least about 90 wt%, such as at least about 95 wt% of the strands in the OSB are oriented substantially parallel to the lengthwise (longitudinal) direction 24 of the piece 1. Arranging the layers in this parallel orientation provides maximum stiffness along the lengthwise (longitudinal) direction 24 of the piece 1 and minimizes the linear expansion in this direction as well as provides improved split-resistance and screw-holding strength.

[0026] The laminated wood pieces are made by laminating together the wood composite piece 5 to the solid hardwood piece 3. The solid hardwood component 3 is a single piece of solid hardwood which may be made from wood species such as maple, oak, cherry, walnut. The wood composite material 5 is manufactured according to typical methods of manufacturing wood composite panels (not shown) and a section of this wood composite panel is cut to attach to the solid hardwood component 3 to form the laminated wood piece. (The width of this cut section itself determines the width of the laminated wood piece 1.) Either the top or bottom surface of the section of the wood composite panel is placed in contact with the solid hardwood component 3 and the components attached (preferably, adhesively bonded) together to form a laminated wood composite piece, which is suitable for use as a door stile. Methods of attaching the wood composite material 5 to the solid hardwood component 3 are discussed in greater detail below.

[0027] The laminated wood piece 1 may have a thickness, T, of about 0.9 cm to about 6 cm, such as about 1.25 cm to about 6 cm, such as about 2.8 cm to about 3.8 cm; and a width, W, of about 3 cm to about 6 cm, such as about 3.5 cm to about 4.5 cm. 1.655 inches is the standard thickness for a door stile. The total door thickness is the sum of the stile thickness plus the thickness of the veneer layers and crossbands, which are described below. Individually, the thickness of the solid hardwood component is about 0.3 cm to about 1.3 cm, preferably about 0.6 cm to about 1.1 cm, and the thickness of the wood composite component is about 0.6 cm to about 5 cm, preferably about 2.2 cm to about 3.3 cm. The ratio of a thickness of the solid hardwood component to a thickness of the wood composite component is from about 1:1 to about 1:10, such as from about 1:2 to about 1:5.

[0028] As is shown in Figure 2, the layers 9 of the wood composite component 5 are arranged to be substantially parallel to the upper surface and lower surface of the solid hardwood component 3. A screw 11 (or nail or similar fastening device suitable to attach metal fixtures to a door stile) is inserted into the piece 1, travels through the solid hardwood component 3, and then enters in a perpendicular direction to the layers 9 of the wood composite component 5. The screw 11 is held firmly in place by the solid hardwood component 3 and the dense layers 9 of the wood composite component 5. The internal bonding strength of the dense wood composite component 5 cooperates with the good bonding strength provided by the solid

hardwood component 3 so that the wood composite piece 1 has excellent screw holding and split resistance properties.

[0029] Preferably, the wood composite component 5 is made from OSB material, the strands being oriented substantially parallel to the lower surface 16 of the solid hardwood component 3. Preferably, at least about 90 wt%, such as at least about 95 wt% of the strands in the OSB are oriented substantially parallel to the lengthwise (longitudinal) direction 24 of the piece 1. This orientation provides maximum stiffness and minimizes linear expansion in the lengthwise direction as well as enhancing the strength properties of the laminated wood piece 1.

[0030] The oriented strand board is derived from a starting material that is naturally occurring hard or soft woods, singularly or mixed, whether such wood is dry (having a moisture content of between 2 wt% and 12 wt%) or green (having a moisture content of between 30 wt% and 200 wt%). Typically, the raw wood starting materials, either virgin or reclaimed, are cut into strands, wafers or flakes of desired size and shape, which are well known to one of ordinary skill in the art.

[0031] After the strands are cut they are dried in an oven and then coated with a special formulation of one or more polymeric thermosetting binder resins, waxes and other additives. The binder resin and the other various additives that are applied to the wood materials are referred to herein as a coating, even though the binder and additives may be in the form of small particles, such as atomized particles or solid particles, which do not form a continuous coating upon the wood material. Conventionally, the binder, wax and any other additives are applied to the wood materials by one or more spraying, blending or mixing techniques, a preferred technique is to spray the wax, resin and other additives upon the wood strands as the strands are tumbled in a drum blender.

[0032] After being coated and treated with the desired coating and treatment chemicals, these coated strands are used to form a multi-layered mat. The coated wood materials (in the form of strands) are spread on a conveyor belt with the top and bottom exterior layers being the surface layer and one or more interior "core" layers. The wood strands are positioned on the conveyor belt oriented substantially parallel to the lower surface 16 of the solid hardwood component 3, and preferably, at least about 90 wt%, such as at least about 95 wt% of the strands in the OSB are oriented substantially parallel to the lower surface 16 of the solid hardwood component 3.

[0033] Various polymeric resins, preferably thermosetting resins, may be employed as binders for the wood flakes or strands. Suitable polymeric binders include isocyanate resin, urea-formaldehyde, phenol formaldehyde, melamine formaldehyde ("MUF") and the co-polymers thereof. Isocyanates are the preferred binders, and preferably the isocyanates are selected from the diphenylmethane-p,p'-diisocyanate group of polymers, which have NCO-functional groups that can react with other organic groups to form polymer groups such as polyurea, –NCON–, and polyurethane, – NCOON–. 4,4-diphenyl-methane diisocyanate ("MDI") is preferred. A suitable commercial MDI product is Rubinate pMDI available from ICI Chemicals Polyurethane Group. Suitable commercial MUF binders are the LS 2358 and LS 2250 products from the Dynea corporation.

[0034] The binder concentration is preferably in the range of about 3 wt% to about 8 wt%. A wax additive is commonly employed to enhance the resistance of the OSB panels to moisture penetration. Preferred waxes are slack wax or an emulsion wax. The wax loading level is preferably in the range of about 1wt% to about 3.0 wt % (based on the weight of solids).

[0035] After the multi-layered mats are formed according to the process discussed above, they are compressed under a hot press machine that fuses and binds together the wood materials, binder, and other additives to form consolidated OSB panels of various thickness and sizes. The high temperature also acts to cure the binder material. Preferably, the panels of the invention are pressed for 2-15 minutes at a temperature of about 175°C to about 240°C. The resulting composite panels will have a density in the range of about 35 lbs/ft^3 to about 48 lbs/ft^3 (as measured by ASTM standard D1037-98). The density ranges from 40 lbs/ft^3 to 48 lbs/ft^3 for southern pine, and 35 lbs lbs/ft^3 to 42 lbs/ft^3 for Aspen. The thickness T' of the OSB panels, as shown in Figure 4, will be from about 0.6 cm (about 1/4") to about 5 cm (about 2"), such as about 1.25 cm to about 6 cm, such as about 2.8 cm to about 3.8 cm.

[0036] After being compressed in the hot press machine, the moisture content of the panels should be between about 6 wt% to about 8 wt%, which matches the moisture content of the solid hardwood component that the OSB is laminated to in forming the stile. If the moisture content of the OSB does not match that of the solid hardwood, then the laminated wood piece is liable to bow during use on account of the linear expansion of the OSB. The OSB panel was

then cut into sections, as shown in Figure 4, with the width W' of each section being exactly identical to the width of the stiles 1 and 13, and correspondingly the width of the rails 12 and 14. Thus, the width of the sections were about 3 cm to about 6 cm, such as about 3.5 cm to about 4.5 cm.

[0037] The wood composite component 5 (e.g., the OSB panel made according to the aforementioned procedure) and the solid hardwood component 3 are then attached to each other to form a wood composite stile 1, such as by adhesively bonding them together. Common wood adhesives, such as polyvinyl alcohol ("PVA") is applied to each of the components and the components brought into contact with each other to form an adhesive bond. The components may then be clamped and held together for several hours to promote the establishment of a good adhesive bond. If desired, an RF laminating apparatus may be used. This apparatus has a RF heating plate that emanates a RF high frequency electric field, which heats and cures the adhesive.

[0038] In operation, an adhesive is applied to the lower surface 14 of the solid hardwood component 3 or one of the surface layers of the wood composite component 5, and then the components are brought into contact with each other to from a laminated wood piece 1. Then the laminated wood piece 1 was arranged on a conveyor and introduced into the RF laminating apparatus in such a way that the surfaces to which the glue was applied were oriented perpendicular to the plane of the RF heating plate. Lateral pressure was applied to the laminated wood piece 1 to assure good contact between the wood composite component 5 or the solid hardwood component 3 while they are under RF heating. The curing time (or the amount of time that the laminated wood piece 1 is exposed to the RF high frequency electric field) should be between 1 to 3 minutes, depending on type of equipment, type of glue and amount of RF power.

[0039] As shown in Figure 3, the wood composite piece 1 may be incorporated as a stile member in the frame of a composite door 15. By "stile member" it is meant that the wood composite piece forms the part of the frame that is placed adjacent to the vertical edge of the door, the stile member need not run the entire vertical length of the door. The composite door 15 in figure 3 includes a rectangular wood frame formed by door stiles 11 and 13 (which run along the vertical edge of the door 15), a top rail 14 and a bottom rail 12, all of which have the same cross section. In the preferred embodiment, the stiles 11 and 13 run the full length of

the frame and overlie and abut the ends of the rails 12 and 14. The two stiles have a length of about 120 cm to about 305 cm, preferably about 215 cm to about 245 cm. The width and thickness of the stiles are the same as set forth above for the laminated wood piece.

[0040] Preferably, the space enclosed by the frame 19 is substantially filled with a core 20, although the space can instead be relatively empty or contain a Z-type member or the like. The core 20 can be a solid hardwood or a wood composite material, or made from various types of thermoplastic or thermosetting materials, compressed mineral board, organic or inorganic fillers, or honey-comb structures, as well as any other suitable core-forming material. Particularly preferred are polymeric foam materials or wood composites like particleboard. As shown in Figure 3, the stiles 11, 13 are positioned adjacent to the core 20, with the wood composite component 5 in contact with the core 20, and the solid hardwood component 3 located on the outer side of the wood composite 5.

[0041] The entire frame and core is covered on each side by a doorskin 22. A crossband 14 may be used between the core and hardwood doorskin to prevent telegraphing (when the texture of the core shows through the veneer). This crossband 14 is typically made of low density hardwood veneer or high density fiberboard with a thickness of at least 1/16 inch. Each doorskin may be made from many different types of materials including wood veneers made from different species of solid woods and different types of wood composites. Also suitable are compression molded resins incorporating reinforcing fibers, as well as moldings made through resin transfer molding, vacuum assisted resin intrusion, rotational molding, low and high pressure injection molding. For architectural doors, suitable doorskin materials include hardwood veneers, and high pressure decorative laminate (HPDL) door faces. Regardless of the material used, it is generally preferred that the doorskins 22 have an appearance simulating a wood grain. When finally assembled, the sum of the thickness of the surface skins 22 and the wood frame 19 should approximate the thickness of the door frame in which the door is to be installed.

[0042] The assembly of the rails, stile and core to form a composite door is preferably carried out on a flat table to facilitate the even registration of the frame elements with respect to each other and to the core. Preferably adhesive bonding is used and common wood adhesives, such as PVA, are acceptable. The attachment between adjoining members of the frame as well as between the core and frame can be made by adhesives, staples, nails, screws or any other

fastening technologies known to those of ordinary skill in the art. The elements of the frame may be attached or secured to each other and then the assembled frame attached to the core, or the elements of the frame may be individually attached and assembled directly onto the core 20 of the door. Alternatively, when the core 20 is made from a foam material, the frame 19 may be assembled first, and the foam material then supplied (or poured) in liquid form into the frame 19 to form the core 20.

[0043] Example I

[0044] Split resistance and screw holding tests were carried out with a laminated wood composite piece composed of an OSB wood composite component cut from an OSB panel and laminated to a solid maple hardwood component.

[0045] The OSB panels were formed as follows. The wood strands were blended in a drum blender with the 1 wt% to 3 wt% wax and 3 wt% to 8 wt% MDI polymeric binder for approximately 2 minutes. The strands were then deposited on a conveyor belt to form a mat and the mat was then hot-pressed to form an OSB panel. Hot press conditions were as follows: (1) press closing time: 40 seconds, (2) press cooking time: 260 seconds, (3) de-gas time: 20 seconds, (4) press control temperature: 225°C (430°F). The OSB panel thereby produced has a density of 44.6 lbs/ft^3, a thickness of 0.945 inches, and a final moisture content of 5.9 wt% to 6.4 wt%. After being sanded on both sides, the final thickness of the panel was 0.875 inches.

[0046] A section having a width of 1.655 inches was cut from the OSB panel and laminated to the solid hardwood maple piece to form a wood composite piece prepared according to the present invention. The section from the OSB panel and the solid hardwood maple piece were attached to each other in the following fashion: the PVA glue was applied to the OSB piece, and the maple hardwood piece and OSB piece clamped together to assure good contact. The pieces remained clamped for at least 4 hours, and after release, the assemblies were conditioned at room temperature for at least 48 hours before testing. The final thickness of the laminated wood piece thus formed was 1.25 inches.

[0047] This section of the wood composite piece was then compared with a section of a prior art product, *viz.* Trus Joint MacMillan's TIMBERSTRAND™ product, which is solid maple hardwood laminated to a piece of oriented strand board made from aspen wood strands. As can be seen in Figure 5, in the TIMBERSTRAND™ product 32, unlike the laminated wood pieces prepared according to the present invention, the layers 44 of the wood composite

component 46 (which is in this case OSB) are arranged perpendicular to the lower surface 41 and upper surface 39 of the solid hardwood component 35.

[0048] The Split resistance of these laminated wood pieces was tested according to the protocol laid out in National Wood Windows and Door Association ("NWWDA") standard TM-5-1990. The laminated wood piece as prepared above was cut into a three inch long specimen, and a sufficient of the wood composite material trimmed off the piece so that the overall thickness of this specimen was one inch. The specimen was conditioned to be at an equilibrium moisture content of 75°F ± 10°F and 50% ± 5% relative humidity. Next 0.134 inches (plus or minus 0.005 inches) was cut away from the upper surface 14 of the solid hardwood component 3 (to simulate the removal of material in preparing to attach a hinge leaf to the laminated wood piece). Then a one-half inch diameter hole was drilled through the specimen, the hole being centered on the diagonal intersection of two lines, each of which connect opposite corners of the upper surface 14 of the solid hardwood component 3.

[0049] The apparatus used to conduct the test was an Instron hydraulic testing machine having a moveable crosshead to apply a tensile load via a split dowel road to the testing specimens. The specimen was mounted with the split dowel rod inserted in the one-half inch hole described above. The specimen was oriented with the three inch length perpendicular to the direction of the load (applied in tension), and the load then applied continuously at a rate of motion of the moveable crosshead of 0.1 inches (2.5 mm) per minute. The maximum load that can be applied before the specimen begins to split is the split resistance of the section. This test was repeated with an additional 15 specimens, and the results averaged.

[0050] The split resistance for the laminated wood pieces prepared according to the present invention was in excess of 1200 lbs, the exact measurement is not known because at a 1200 lbs load the laminated wood piece had not broken, but the test had to be discontinued for safety reasons. By contrast, the TIMBERSTRAND™ product had a significantly smaller split resistance of 311 lbs.

[0051] The screw-holding capacity was tested according to the protocol laid out in National Wood Windows and Door Association ("NWWDA") standard TM-10. As in the split resistance test described above, a three inch specimen of the laminated wood piece was cut, and a sufficient of the wood composite material trimmed off the piece so that the overall thickness of this specimen was one inch. The specimen was conditioned to be at an equilibrium moisture

content at 75°F ± 10°F and 50% ± 5% relative humidity. Next 0.134 inches (plus or minus 0.005 inches) was cut away from the upper surface 14 of the solid hardwood component 3. A 1/8 inch drill bit was used to drill a hole in the specimen, and a 2 inch long #10 screw inserted into the hole. The root diameter was about 0.138 inches.

[0052] The plate was then positioned on top of the specimen and the screw inserted through the plate hole and into the lead hole deep enough to engage one inch of the constant diameter portion of the threads, being careful to insert the screw with a turning motion so as not to reduce the thread engagement strength of the specimen. The specimen was then inserted into the load applying holding attachment of the hydraulic tensioning apparatus with the screw head up, and the screw head engaged by the holding attachment. A tensile load applied continuously at a rate of motion of the moveable crosshead of 0.1 inches (2.5 mm) per minute.

[0053] The screw withdrawal capacity for the laminated wood pieces prepared according to the present invention was 936 lbs for the OSB composite material itself (without the hardwood) and 1035 lbs for the wood composite piece overall (with the hardwood). By contrast, the TIMBERSTRAND™ product had a screw withdrawal capacity of 708 lbs (without the hardwood layer) and 1017 lbs for the wood composite piece overall (with the hardwood). Thus, the laminated wood piece prepared according to the present invention has significantly higher screw withdrawal performance than the prior art.

[0054] This data demonstrates that laminated wood composite pieces in which the wood composite layers are oriented parallel to the lower surface of the solid hardwood component (and thus, the layers are perpendicular to the direction at which the screw enters the wood composite layers) has a split resistance and screw holding capacity that are significantly better than prior art laminated wood composite pieces in which the wood composite layers are perpendicular to the lower surface of the solid hardwood component (and thus, parallel to the direction that the screw enters). Such results would be unexpected by one of ordinary skill in the art.

[0055] It will be appreciated by those skilled in the art that changes could be made to the embodiments described above without departing from the broad inventive concept thereof. It is understood, therefore, that this invention is not limited to the particular embodiments disclosed, but it is intended to cover modifications within the spirit and scope of the present invention as defined by the appended claims.